

WHAT IS CLAIMED IS:

1. A method of manufacturing a semiconductor device, comprising:

5 forming a film containing metal elements and silicon elements on a semiconductor substrate; exposing the semiconductor substrate to an atmosphere containing an oxidant to form a silicon dioxide film at the interface between the semiconductor substrate and the film containing metal elements and 10 silicon elements; and

nitriding the film containing metal elements and silicon elements after forming the silicon dioxide film.

15 2. A method of manufacturing a semiconductor device, according to claim 1, wherein the metal elements includes at least one of Zr, Hf, Al and La.

20 3. A method of manufacturing a semiconductor device, according to claim 1, wherein the film containing metal elements and silicon elements is formed by using CVD.

4. A method of manufacturing a semiconductor device, according to claim 1, wherein the film containing metal elements and silicon elements contains oxygen or nitride.

25 5. A method of manufacturing a semiconductor device, according to claim 1, wherein the film containing metal elements and silicon elements contains

oxygen and nitride.

6. A method of manufacturing a semiconductor device, according to claim 1, wherein the film containing metal elements and silicon elements is
5 formed by using an alkoxide or an amide compound as a precursor.

7. A method of manufacturing a semiconductor device, according to claim 6, wherein the alkoxide is at least one of tetra ethoxy silane and hafnium tetra
10 tertiary butoxide.

8. A method of manufacturing a semiconductor device, according to claim 6, wherein the amide compound is made of at least one of tetraxy diethyl amide hafnium and tetraxy dimethyl amide silicon.

15 9. A method of manufacturing a semiconductor device, according to claim 1, wherein the film containing metal elements and silicon elements is formed by using an alkoxide and an amide compound as a precursor.

20 10. A method of manufacturing a semiconductor device, according to claim 9, wherein the alkoxide is at least one of tetra ethoxy silane and hafnium tetra tertiary butoxide.

25 11. A method of manufacturing a semiconductor device, according to claim 9, wherein the amide compound is made of at least one of tetraxy diethyl amide hafnium and tetraxy dimethyl amide silicon.

12. A method of manufacturing a semiconductor device, according to claim 1, wherein the atmosphere containing an oxidant is an atmosphere of a partial pressure of an oxidant is 0.1 Torr or less.

5 13. A method of manufacturing a semiconductor device, according to claim 1, wherein the atmosphere containing an oxidant is one of an oxidation atmosphere containing an active oxidation species, a low temperature plasma oxidation atmosphere, a low pressure 10 O₂ oxidation atmosphere, a low pressure H₂O oxidation atmosphere, and a low pressure N₂O oxidation atmosphere.

15 14. A method of manufacturing a semiconductor device, according to claim 13, wherein a low pressure O₂ oxidation atmosphere, a low pressure H₂O oxidation atmosphere, and a low pressure N₂O oxidation atmosphere is a reduced atmosphere at a temperature of 800°C or less.

20 15. A method of manufacturing a semiconductor device, according to claim 1, wherein nitriding the film containing metal elements and silicon elements is carried out by using a nitrogen radical or nitrogen plasma.

25 16. A method of manufacturing a semiconductor device, according to claim 1, wherein nitriding the film containing metal elements and silicon elements is carried out by using an NH₃ nitridation method.

17. A method of manufacturing a semiconductor device, comprising:

forming a film containing metal elements and silicon elements on a semiconductor substrate;

5 exposing the semiconductor substrate to an atmosphere containing an oxidant to form a silicon dioxide film at the interface between the semiconductor substrate and the film containing metal elements and silicon elements;

10 nitriding the film containing metal elements and silicon elements to form a gate insulating film comprising the silicon dioxide film and a nitrided film containing metal elements and silicon elements;

forming a gate electrode on the gate insulating

15 film; and

forming source/drain regions in the surface region of the semiconductor substrate to sandwich a region covered by the gate electrode.